REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
22 Jan 2013	Consultative Letter	Sep 2012 – Jan 2013

4. TITLE AND SUBTITLE
321 B North and PRL-S006 Verification Surveys at Former McClellan AFB, Sacramento, CA

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Maj Alan Hale

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USAF School of Aerospace Medicine
Occupational and Environmental Health Dept/OEC
2510 Fifth St.
Wright-Patterson AFB, OH 45433-7913

8. PERFORMING ORGANIZATION REPORT NUMBER
AFRL-SA-WP-CL-2013-0002

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution A: Approved for public release; distribution is unlimited. Case Number: 88ABW-2013-0237, 22 Jan 2013

13. SUPPLEMENTARY NOTES

14. ABSTRACT
At the request of the USAF Radioisotope Committee Secretariat (RICS), the USAF School of Aerospace Medicine Consultative Services Division completed an independent radiological assessment/verification survey of sites 321 B North and PRL-S006 at former McClellan AFB, CA, from 12-13 Sep 12. This verification survey was conducted at each of the sites post-remediation and after the contractor had completed its Final Status Survey (FSS) sampling. Radium-226 was the sole radionuclide of concern. Environmental Dimensions, Inc., under contract with CH2M Hill, conducted all radiological field work to include FSSs. This letter details the findings of this visit and is meant to assist the RICS when evaluating the contractor's FSS reports of these sites.

15. SUBJECT TERMS
USAF School of Aerospace Medicine (USAFSAM), former McClellan AFB, radium-226, verification survey, final status survey, independent radiological assessment

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Col Mark E. Smallwood
U	U	U	SAR	22	19b. TELEPHONE NUMBER *(include area code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OHIO 45433

22 January 2013

MEMORANDUM FOR AFMSA/SG3PB
Attn: Maj Daniel Shaw
USAF Radioisotope Committee Secretariat
Air Force Medical Support Agency
7700 Arlington Boulevard, Suite 5158
Falls Church, VA 22042-5158

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0002, 321 B North and PRL-S006 Verification Surveys at Former McClellan AFB, Sacramento, CA

1. Introduction:

a. *Purpose:* At the request of the USAF Radioisotope Committee Secretariat (RICS), the USAF School of Aerospace Medicine Consultative Services Division (USAFSAM/OEC) completed an independent radiological assessment/verification survey of sites 321 B North and PRL-S006 at former McClellan AFB, CA, from 12-13 Sep 12. This verification survey was conducted at each of the sites post-remediation and after the contractor had completed its Final Status Survey (FSS) sampling. Radium-226 (Ra-226) was the sole radionuclide of concern. Environmental Dimensions, Inc. (EDi), under contract with CH2M Hill, conducted all radiological field work to include FSSs. This letter details the findings of this visit and is meant to assist the RICS when evaluating the contractor's FSS reports of these sites.

b. *Survey Personnel:*

Maj Alan Hale, Chief, Radiation Health Consulting Branch, USAFSAM/OEC

c. *Personnel Contacted:*

(1) Mr. Milton (Buddy) Walser, Radiation Program Manger, AFCEC/CIBW
(2) Mr. Philip Mook, Senior Representative, AFCEC/CIBW

d. *Equipment:*

(1) Ludlum – Model 2221, serial number 218606, calibrated on 23 Nov 11
(2) Ludlum – Model 44-10, serial number PR276614, calibrated on 23 Nov 11

2. Methodology:

a. *Background Area*. The background area of 400 m^2 has been routinely used as a reference area, since it has been determined to be radiologically nonimpacted. The background area was characterized with the 2x2 sodium iodide detector using a gamma walkover technique. No soil samples were taken in the background area, as the background soil concentrations for former McClellan AFB have been determined previously and were not relevant for this survey. After gamma walkover surveys at the survey sites, it was determined that the background area was not consistent with the survey areas, most likely due to the fact the background area still had vegetation in place. The background data are therefore irrelevant and are not presented.

b. *Survey Areas*. EDi was responsible for conducting a total of 17 FSSs across 17 different sites. The week of the visit, three sites were available for USAFSAM verification. After consultation with the RICS, two of these sites were chosen for verification survey: 321 B North and PRL-S006. The survey areas underwent gamma walkover surveys and soil sampling. This verification survey required at least 10% of the survey area to be scanned by the gamma walkover technique and soils sampling numbering at least 10% of the number taken by the contractor. Further information on the surveys can be found in Attachments 1-3.

(1) Gamma Walkover Survey in Survey Areas. The goals of the walkover survey were to detail site radiological conditions, identify potential spots of elevated residual Ra-226 concentrations, and identify locations for biased soil sampling. Since the gamma walkover data were to qualitatively assess the site in terms of mean reading plus amount of standard deviation (SD), minimum detectable concentration and count rates were not calculated. Table 1 in section 3 summarizes the results of the gamma walkover survey.

(2) Soil Sampling in Survey Areas. Since the contractor planned to collect less than 20 soil samples in each survey area, two biased soil samples were collected based on walkover data exhibiting elevated count rates. Each sample was taken from an area of about 8 in^2 to a depth of 6 in. The volume sampled was enough for laboratory analysis (approximately 0.25 gal). Field soil sampling procedures were in place to prevent cross-contamination of samples. Table 2, in section 3, summarizes the soil sample results.

3. Results. The results are summarized below along with some basic discussion. Additional substantiating data, including maps and survey data, can be found in Attachments 1-4.

Table 1. Gamma Walkover Results Summary

Survey Unit	Approximate Scan Coverage (%)	Mean Count Rate (cpm)	SD (cpm)	No. of Readings > Mean + 3 SD
321 B North	75	9182	550	3
PRL-S006	100	10777	862	0

Table 2. Soil Sampling Results Summary

Sample No.	Survey Unit	Ra-226 Concentration (pCi/g)	Ra-226 Concentration Uncertainty (pCi/g)
0GS0001	321 B North	0.890	±0.0417
0GS0002	321 B North	0.679	±0.0372
0GS0003	PRL-S006	0.794	±0.0427
0GS0004	PRL-S006	0.708	±0.0446

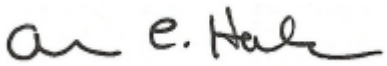
4. Conclusions:

a. All soil samples were taken in biased locations where the expected maximum Ra-226 concentrations were expected to be found. The maximum Ra-226 concentration was 0.890 ± 0.0417 pCi/g. All the concentrations were less than the cleanup goal of 2.0 pCi/g, which is inclusive of background.

b. Based upon the findings of this verification survey, USAFSAM finds that sites 321 B North and PRL-S006 are suitable for unrestricted free release of radiological controls, assuming the contractor reached the same results during its more comprehensive FSS.

c. If these independent verification surveys are consistent with EDi's results, the RICS should have increased confidence in the contractor's FSS reports at all 17 remediated areas.

5. If you have any questions or need further information, please contact Maj Alan Hale at 937-938-3320 (DSN 798-3320) or alan.hale@us.af.mil.



ALAN C HALE, Maj, USAF, BSC
Chief, Radiation Health Consulting Branch

Attachments:
1. Instrumentation and Survey Methodology
2. Survey of 321 B North
3. Survey of PRL-S006
4. Laboratory Soil Analysis
5. Instrument Calibration Sheets
6. Radiation Meter Quality Control (QC) Log

ATTACHMENT 1

INSTRUMENTATION AND SURVEY METHODOLOGY

1. Sodium Iodide Detector: The sodium iodide detector used was Ludlum 44-10 2x2-in detector coupled with a Ludlum 2221 Ratemeter/Scaler. For walkover surveys, the Ludlum 2221 was connected via cable to a Trimble GeoXT handheld GPS unit. The Trimble GeoXT logged the count rates with the corresponding GPS coordinates every 1 s. The detector was held at 10 cm above the ground for soil readings and walkover surveys. During walkovers, the scan speed was approximately 0.5 m/s. This is consistent with the methodology EDi used during gamma walkover surveys.

2. Laboratory Analysis of Soil. Soil samples were counted at the USAFSAM Radioanalytical Laboratory (OEAL) at WPAFB, OH. The soil was counted on a high purity germanium detector. The soils were also analyzed by OEAL using the appropriate in-growth method to determine Ra-226 levels in soil. Attachment 4 contains the laboratory reports.

3. All field instruments were function checked and field tested before and after use with check sources. All instruments were within a 25% tolerance during field checks. All instruments are calibrated on an annual basis at WPAFB, OH. Attachment 5 contains all annual calibration sheets, and Attachment 6 is the Radiation Meter QC Log.

ATTACHMENT 2

SURVEY OF 321 B NORTH

1. Location. Figure A2-1 is a photograph of the 321 B North survey area.

Figure A2-1. Photograph of 321 B North

2. Survey Results. Two samples were taken in the 321 B North survey area. The gross Ra-226 soil concentration results, shown in Table A2-1, are inclusive of the background Ra-226 concentration and can be compared directly to the cleanup goal of 2.0 pCi/g. The locations of the soil samples are in Figure A2-2. The 321 B North survey area of approximately 380 m^2 was characterized with a sodium iodide detector using a gamma walkover technique. Scan coverage was approximately 75%. Due to the shallow nature of the excavation, only the floor of the excavation was scanned and did not include the side walls of the excavation. The resultant data of this walkover are found in Figure A2-3. Since there was a disparity in the mean count rates of the background survey area and the survey unit due to soil difference and through analysis of the statistics, the mean count rate of the survey unit itself and associated statistics were used as the "background" for this survey unit. The lowest readings of the survey are marked in green and correspond to less than 2 SDs above the mean background value. This green area is where soil concentrations are expected to be the lowest. The other colors represent areas of statistical significance, where higher concentrations are expected to be found. Yellow and red colors correspond to greater than 2 and 3 SDs, respectively, above the mean count rate value. The color

scheme demonstrates a scale of instrument data based upon SDs from background, where no regulatory values are implied.

Table A2-1. Soil Sample Results for 321 B North

Sample No.	GPS Coordinates (°N/°E)	Gross Ra-226 Concentration (pCi/g)
0GS0001	38.653394 / -121.403085	0.890 ± 0.0417
0GS0002	38.653384 / -121.402969	0.679 ± 0.0372

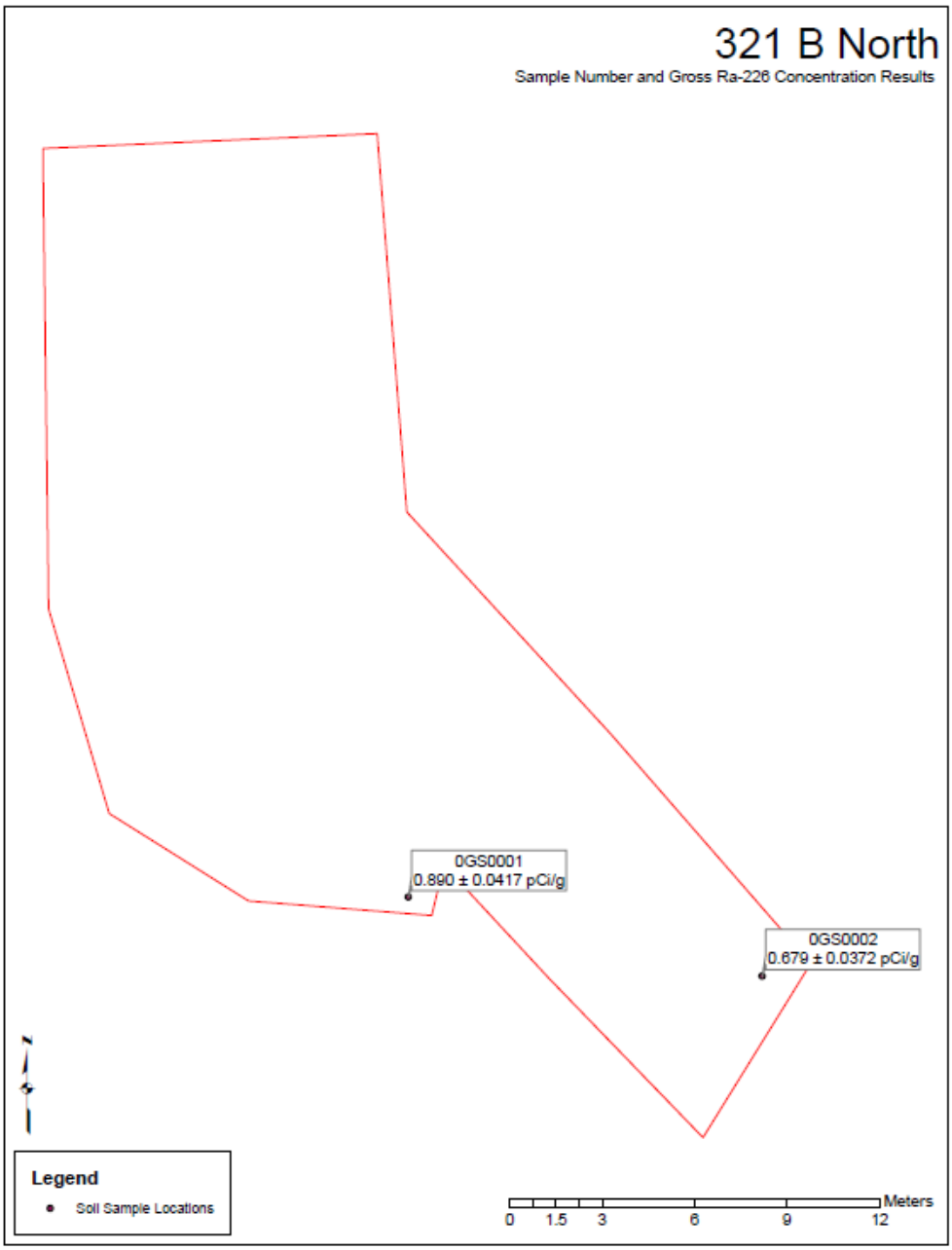


Figure A2-2. Soil Sample Locations for 321 B North

Figure A2-3. Gamma Walkover Data for 321 B North

ATTACHMENT 3

SURVEY OF PRL-S006

1. Location. Figures A3-1, A3-2, and A3-3 are photographs of the PRL-S006 survey area.

Figure A3-1. Photograph of PRL-S006, Overview

Figure A3-2. Photograph of PRL-S006, Viewed from Southwest

Figure A3-3. Photograph of PRL-S006, Viewed from Southeast

2. Survey Results. Two samples were taken in the PRL-S006 survey area. The gross Ra-226 soil concentration results, shown in Table A3-1, are inclusive of the background Ra-226 concentration and can be compared directly to the cleanup goal of 2.0 pCi/g. The locations of the soil samples are in Figure A3-4. The PRL-S006 survey area of approximately 40 m^2 was characterized with a sodium iodide detector using a gamma walkover technique. Scan coverage was approximately 100% of the excavation floor. Due to the deep nature of the excavation, the side walls of the excavation were also scanned, with a coverage of approximately 10%. The map has many points overlayed, since the GPS location uncertainty is on the order of 1 m, the site is small, and the side walls were scanned. The resultant data of this walkover are found in Figure A3-5. Since there was a disparity in the mean count rates of the background survey area and the survey unit due to soil difference and through analysis of the statistics, the mean count rate of the survey unit itself and associated statistics were used as the "background" for this survey unit. The lowest readings of the survey are marked in green and correspond to less than 2 SDs above the mean background value. This green area is where soil concentrations are expected to be the lowest. The other colors represent areas of statistical significance, where higher concentrations are expected to be found. Yellow and red colors correspond to greater than 2 and 3 SDs, respectively, above the mean count rate value. The color scheme demonstrates a scale of instrument data based upon SDs from background, where no regulatory values are implied.

Table A3-1. Soil Sample Results for PRL-S006

Sample No.	GPS Coordinates (°N/°E)	Gross Ra-226 Concentration (pCi/g)
0GS0003	38.654593 / -121.389503	0.794 ± 0.0427
0GS0004	38.654629 / -121.389506	0.708 ± 0.0446

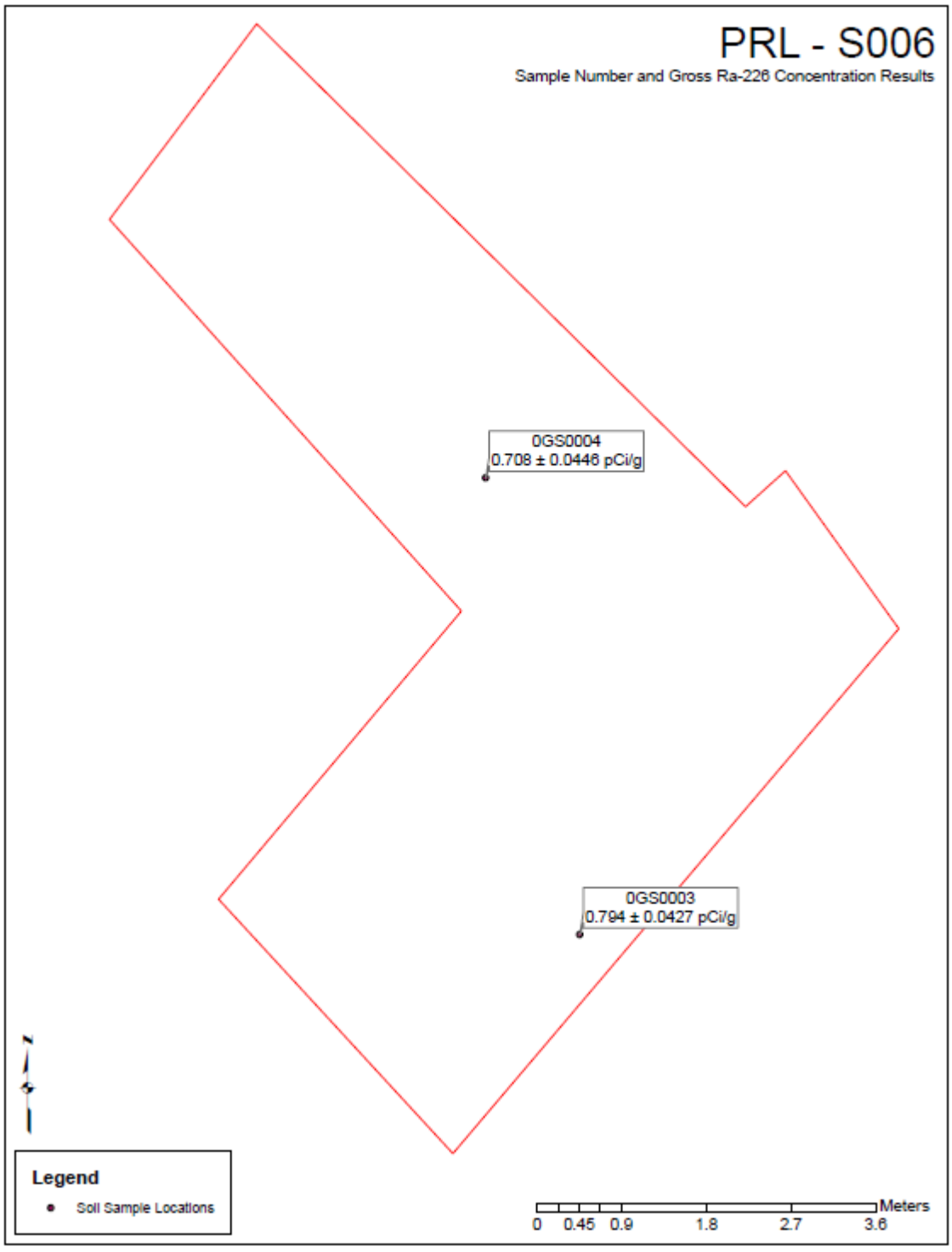


Figure A3-4. Soil Sample Locations for PRL-S006

Figure A3-5. Gamma Walkover Data for PRL-S006

ATTACHMENT 4

LABORATORY SOIL ANALYSIS

Sample Analysis Results Reported on 14-Nov-2012

USAFSAM/OEHHL ID 11200264

Customer Address 0117 Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # 0GS00001 Serial #
Date Collected 9/13/2012 Received 9/17/2012 Completed 11/7/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
POTASSIUM 40	1.54E+01 +/- 9.72E-01 pci/g	2.02E-01 / 4.27E-01 pci/g
RADIUM	8.90E-01 +/- 4.17E-02 pci/g	4.33E-02 / 8.90E-02 pci/g
THALLIUM 208	2.68E-01 +/- 3.33E-02 pci/g	2.24E-02 / 4.62E-02 pci/g
BISMUTH 212	8.84E-01 +/- 2.94E-01 pci/g	2.32E-01 / 4.83E-01 pci/g
LEAD 212	9.34E-01 +/- 5.26E-02 pci/g	3.00E-02 / 6.13E-02 pci/g
RADIUM 224	9.44E-01 +/- 3.32E-01 pci/g	2.75E-01 / 5.64E-01 pci/g
ACTINIUM 228	8.80E-01 +/- 7.54E-02 pci/g	8.03E-02 / 1.67E-01 pci/g
THORIUM 228	2.00E+00 +/- 7.66E-01 pci/g	1.17E+00 / 2.38E+00 pci/g
THORIUM 234	2.35E+00 +/- 8.43E-01 pci/g	1.05E+00 / 2.13E+00 pci/g
URANIUM 235	6.31E-02 +/- 3.26E-02 pci/g	2.64E-02 / 5.36E-02 pci/g

COMMENTS

WORKPLACE: 321 B NORTH

RA 226

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTANITY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

STEVEN C. DEWEY, Major, USAF, BSC
Chief, Radioanalysis Branch

Sample Analysis Results Reported on 14-Nov-2012

USAFSAM/OEHHL ID 11200266

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # 0GS00002 Serial #

Date Collected 9/13/2012 Received 9/17/2012 Completed 11/7/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
POTASSIUM 40	1.58E+01 +/- 9.84E-01 pci/g	2.13E-01 / 4.48E-01 pci/g
RADIUM	6.79E-01 +/- 3.72E-02 pci/g	3.97E-02 / 8.18E-02 pci/g
THALLIUM 208	2.67E-01 +/- 3.53E-02 pci/g	2.55E-02 / 5.22E-02 pci/g
BISMUTH 212	1.01E+00 +/- 3.11E-01 pci/g	2.40E-01 / 4.99E-01 pci/g
LEAD 212	9.07E-01 +/- 1.01E-01 pci/g	3.02E-02 / 6.16E-02 pci/g
RADIUM 224	5.71E-01 +/- 3.27E-01 pci/g	2.70E-01 / 5.54E-01 pci/g
ACTINIUM 228	8.49E-01 +/- 6.76E-02 pci/g	6.81E-02 / 1.42E-01 pci/g
THORIUM 228	9.28E-01 +/- 7.31E-01 pci/g	1.19E+00 / 2.43E+00 pci/g
THORIUM 234	2.59E+00 +/- 7.81E-01 pci/g	1.08E+00 / 2.19E+00 pci/g
RADIUM 226	1.57E+00 +/- 4.95E-01 pci/g	3.87E-01 / 7.87E-01 pci/g

COMMENTS

WORKPLACE: 321 B NORTH

RA 226

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTANITY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

STEVEN C. DEWEY, Major, USAF, BSC
Chief, Radioanalysis Branch

Sample Analysis Results Reported on 14-Nov-2012

USAFSAM/OEHHL ID 11200263

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # 0GS00003 Serial #

Date Collected 9/13/2012 Received 9/17/2012 Completed 11/7/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
POTASSIUM 40	1.57E+01 +/- 1.03E+00 pci/g	2.33E-01 / 4.92E-01 pci/g
RADIUM	7.94E-01 +/- 4.27E-02 pci/g	4.22E-02 / 8.68E-02 pci/g
THALLIUM 208	2.67E-01 +/- 3.62E-02 pci/g	2.51E-02 / 5.18E-02 pci/g
BISMUTH 212	1.13E+00 +/- 3.61E-01 pci/g	2.76E-01 / 5.75E-01 pci/g
LEAD 212	1.06E+00 +/- 1.21E-01 pci/g	3.62E-02 / 7.39E-02 pci/g
RADIUM 224	1.40E+00 +/- 4.46E-01 pci/g	3.21E-01 / 6.59E-01 pci/g
ACTINIUM 228	9.95E-01 +/- 6.93E-02 pci/g	7.34E-02 / 1.54E-01 pci/g
THORIUM 228	1.70E+00 +/- 9.71E-01 pci/g	1.34E+00 / 2.72E+00 pci/g
THORIUM 232	1.64E+01 +/- 1.58E+01 pci/g	1.29E+01 / 2.62E+01 pci/g
URANIUM 235	7.08E-02 +/- 3.58E-02 pci/g	2.91E-02 / 5.92E-02 pci/g

COMMENTS

SEND RESULTS ALSO TO MAJ ALAN HALE DSN: 798-3320

WORKPLACE: PRL-5006

RA 226

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

STEVEN C. DEWEY, Major, USAF, BSC
Chief, Radioanalysis Branch

Sample Analysis Results Reported on 14-Nov-2012

USAFSAM/OEHHL ID 11200265

Customer Address 0117 Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # 0GS00004 Serial #
Date Collected 9/13/2012 Received 9/17/2012 Completed 11/7/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
POTASSIUM 40	1.52E+01 +/- 9.77E-01 pci/g	2.23E-01 / 4.68E-01 pci/g
RADIUM	7.08E-01 +/- 4.46E-02 pci/g	4.19E-02 / 8.59E-02 pci/g
THALLIUM 208	3.56E-01 +/- 3.45E-02 pci/g	2.00E-02 / 4.14E-02 pci/g
BISMUTH 212	1.07E+00 +/- 2.89E-01 pci/g	2.29E-01 / 4.78E-01 pci/g
RADIUM 224	9.27E-01 +/- 3.20E-01 pci/g	2.70E-01 / 5.54E-01 pci/g
ACTINIUM 228	1.12E+00 +/- 7.62E-02 pci/g	7.19E-02 / 1.50E-01 pci/g
THORIUM 228	1.34E+00 +/- 7.80E-01 pci/g	1.02E+00 / 2.09E+00 pci/g
THORIUM 234	1.90E+00 +/- 8.45E-01 pci/g	1.06E+00 / 2.15E+00 pci/g
URANIUM 235	6.99E-02 +/- 3.30E-02 pci/g	2.66E-02 / 5.41E-02 pci/g

COMMENTS

WORKPLACE: PRL-5006

RA 226

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTANITY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

STEVEN C. DEWEY, Major, USAF, BSC
Chief, Radioanalysis Branch

ATTACHMENT 5

INSTRUMENT CALIBRATION SHEETS

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)
WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Mfg. Ludlum Model 2221 Serial # 218606 Index # 099333 Date: 23 Nov 11
Mfg. Ludlum Model 44-10 Serial # PR276614 Index # 100861 Cal. Due Date: 23 Nov 12

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources				Reference Instruments			
Isotope	*Serial #*	*Cert. Date*	*DPM*	*Mfg.*	*Model*	*Serial #*	*Cal. Due Date*
Cs-137	**RP3067**	**1 Nov 04**	**2,454,000**	**Ludlum**	**500-1**	**102951**	**8 Feb 2012**

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☑ Battery Ck. ☑ Mechanical Ck. ☑ Meter Zeroed ☑ Reset Ck. NA Alarm Ck.
☑ Audio Ck. ☑ Geotropism Ck. ☑ F/S Resp. Ck. ☑ Window Op.

As Found HV 991 VDC Temperature 72.7 °F Relative Humidity 55 %

Final Volt. Set 100 VDC Threshold (LLD) 10 mV Window (ULD) 20 mV Window width 10 mV

HV Readout (2 points) Reference: 500 V Inst. Readout: 500 V ± 2% Reference: 1000 V Inst. Readout: 1000 V ± 2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING		CORRECTED READING	
x 1000	400 CPM	400,000	CPM	400,000	CPM
x 1000	100 CPM	100,000	CPM	100,000	CPM
x 100	400 CPM	40,000	CPM	40,000	CPM
x 100	100 CPM	10,000	CPM	10,000	CPM
x 10	400 CPM	4,000	CPM	4,000	CPM
x 10	100 CPM	1,000	CPM	1,000	CPM
x 1	400 CPM	400	CPM	400	CPM
x 1	100 CPM	100	CPM	100	CPM
Log Scale	200 CPM	200	CPM	200	CPM

DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING		CORRECTED READING	
40,000 CPM	39,886	CPM	39,886	CPM

*UNCERTAINTY WITHIN ± 10% CORRECTION FACTOR WITHIN ± 20%

COMMENTS: Calibration Interval = 1 year Use "Window Out"
Cs-137 Eff: 6,500 CPM/μci/m² @ 12"
Procedural Authority - ICP#22210000

Calibrated By: Stu Hutchinson Date: 23 Nov 2011
Reviewed By: Piper Will Date: 30 Nov 11

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)
WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Meter
Mfg. Ludlum Model 2221 Serial # 218606 Index # 099333 Date: 23 Nov 11
Cal. Due Date: 23 Nov 12

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources

Isotope	*Serial #*	*Cert. Date*	*DPM*
Cs-137	RP3067	1 Nov 04	2,454,000

Reference Instruments

Mfg.	*Model*	*Serial #*	*Cal. Due Date*
Ludlum	500-1	102951	8 Feb 2012

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

NaI DETECTOR HIGH VOLTAGE OPTIMIZATION

Probe #1
Mfg. Ludlum
Model 44-10
Serial # PR276614
Index # 100861
Isotope: Cs-137

High Voltage	CPM
750	7834
800	9964
850	11523
900	12240
950	12771
1000	12851
1050	13589
1100	13500
1150	13697
1200	13684
1250	13908
1300	13966
1350	17410
Bkgd@ 1100	4664

Final Volt. Set 1100 VDC
Efficiency 6500 CPM/μci/m² @12"

Probe #2
Mfg.
Model
Serial #
Index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ CPM/μci/m² @12"

Probe #3
Mfg.
Model
Serial #
Index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ % 2π@¼"

COMMENTS: Calibration Interval = 1 year Use "Window Out"

Calibrated By: Stu Hutchinson Date: 23 Nov 2011
Reviewed By: [signature] Date: 30/11/11

HotSpot FIDLER Text File Outpu:

HotSoot FIDLER Calibration Informatior

Report Date	:	Nov 23 2011 07:07 AM
Calibration Date	:	23 Nov, 2011
Target Mix	:	Other Nuclide Check Source
Radionuclide	:	Cs-137
Detector Barcode Number	:	100861
Meter Barcode Number	:	099333
Detector Manufacturer	:	Ludlum
Detector Model Number	:	44-10
Detector Serial Number	:	PR276614
Meter Manufacturer	:	Ludlum
Meter Model Number	:	2221
Meter Serial Number	:	218606
Check Source I.D.	:	RP 3067
Calibration Date	:	23 Nov, 2011
Calibrated by	:	Stu Hutchinson
Check Source Activity (uCi):		1.100E+00
Check Source 17-keV Self	:	1.000E+00
Sample Counting Time (minutes)	:	1.000E+00
Detector Height (cm)	:	3.000E+01

Cs-137 Window Information:

Background (cpm)	:	4,669
Areal Limit of Sensitivity (uCi/m2)	:	4.9E-02
Point Limit of Sensitivity (uCi)	:	1.0E-01
K-factor (m2)	:	2.07

Counting Data (counts):

0-cm:	8120
20-cm:	7179
40-cm:	6081
60-cm:	5469
80-cm:	5167
100-cm:	5069

Instrument Type :Other
Window Option:Only 60 keV
Units:Classic
This is an actual 2 x2 calibration and the values are typical of most 2 x2 configurations.

Detector Calibration Results

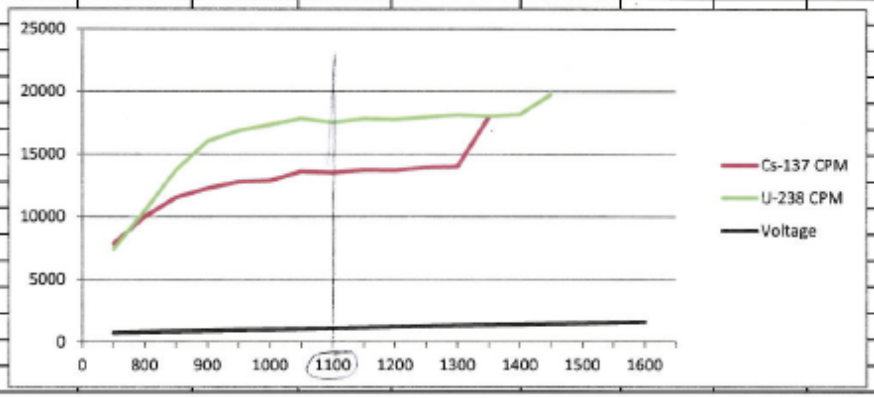
Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2))	:	6.5E+03
Cs-137 Detector Areal LOS (uCi/m2)	:	4.9E-02
Cs-137 Detector Point LOS (uCi)	:	1.0E-01
Cs-137 Detector Background Rate (cpm)	:	4,669
Cs-137 Detector Check Source Rate (cpm)	:	3,451
Cs-137 Detector K-Factor (m2)	:	2.07
Cs-137 Detector K-Factor sdev (%)	:	7.5

Cs-137 Eff: 6,500 CPM/uci/m² @ 12"

Page 1

VDC	CS-137 CPM	DU Slug		Ludlum 2221	SN 218606			
				Ludlum 44-10	SN 276614			
750	7834	7417						
800	9969	10456						
850	11523	13713						
900	12240	16030						
950	12771	16869						
1000	12851	17336						
1050	13589	17835						
1100	13500	17515						
1150	13697	17816						
1200	13684	17764						
1250	13908	17946						
1300	13966	18133						
1350	17910	18023						
1400		18159						
1450		19730						
1500								
1550								
1600								



ATTACHMENT 6

RADIATION METER QC LOG

Radiation Meter QC Log

Model	S/N	Date/Time	HV/cables/Bat check	Source Check Reading	Acceptable Range
2221 SPA3	218606 PR276614	10sep@1335	✓	21015 cpm	16812 - 25218 cpm
2221 SPA3	7815 PR276615	10sep@1337	✓	21,815 cpm	17454 - 26181 cpm
2221 SPA3	218606 PR276614	12sep@1031	✓	20102 cpm	16812 - 25218 cpm
2221 SPA3	218606 PR276614	12sep@1152	✓	19576 cpm	16812 - 25218 cpm
2221 SPA3	218606 PR276614	12sep@1314	✓	22887 cpm	16812 - 25218 cpm
2221 SPA3	218606 PR276614	12sep@1508	✓	19258 cpm	16812 - 25218 cpm
2221 SPA3	218606 PR276614	13sep@0948	✓	19 708 cpm	16812 - 25218 cpm
2221 SPA3	218606 PR276614	13sep@1135	✓	19 689 cpm	16812 - 25218 cpm